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this translation should greatly stimulate observation in a field too much neglected by American botanists.—J. M. C.

Flora of Manchuria.—KOMAROV[11] has completed his *Flora of Manchuria* with the appearance of the second part of the third volume. The whole work contains 853 pages, and the last part includes the Sympetalae from Labiatae to Compositae. It is interesting to note that in presenting 18 families, 130 genera, and 336 species, only two new species are described—one a Scutellaria, the other a Saussurea. An appendix contains descriptions of two new species of Anemone. In this part much the largest families are Compositae (164 spp.), Labiatae (48 spp.), and Scrophulariaceae (43 spp.)—J. M. C.

Grasses of Louisiana.—R. S. COCKS,[12] Tulane University, has published a list of the grasses of Louisiana, based upon collections made during each season since 1897. The catalogue contains 290 species, which is said to represent 12 per cent. of the flora of the state. It is interesting to note that 11 species are known to find their northern limit in Louisiana; 9 species their southern limit; 10 species their western limit; and 10 species their eastern limit; while 5 species are given as occurring only in Louisiana so far as the United States is concerned.—J. M. C.

The western willows.—JONES[13] has published an account of the western Salicaceae, recognizing 53 species of Salix, with numerous varieties, and 8 species of Populus. The species have been studied in the field and the descriptions are compact and clear; so that the willows are presented as they actually appear in nature. A key to the species makes their recognition very direct, and the characters used are very obvious ones. Willows have been difficult to identify, and this presentation should be of much service.—J. M. C.

North American Flora.—The second part of Volume IX concludes Polyporaceae, by W. A. MURRILL, 32 genera being presented, 16 of which have recently been described by the author. In various genera 36 new species are described.—J. M. C.

NOTES FOR STUDENTS

Biometrical studies.—The close interrelation between fluctuations and the environment, especially those factors of the environment which in any way affect nutrition, has been recognized by many authors and overlooked or ignored by others. Several valuable contributions have been made to this subject. In a paper read before the third Flemish Natural History Congress at Antwerp in 1899, MacLeod[14] shows that in *Centaurea Cyanus* the mean numbers of rays and disk-florets are highest in heads which bloom earliest and that they fall continually as the flowering season progresses, the change in disk-florets being the greater. When individuals are considered, the terminal heads have the highest numbers, and each successive bud-generation has a less number than the preceding. Three series of cultures under different conditions of soil led to the conclusion that the first heads of each plant behave like the terminal heads of well-nourished plants; and that the last heads of each plant and of the season resemble the terminal heads of poorly nourished plants. There is no indication in this species that the Fibonacci numbers tend to predominate. This paper is not listed in Davenport's rather comprehensive bibliography, and was unfortunately unknown to me when I was investigating the seasonal variability in *Aster prenanthoides*. The conclusions reached for Centaurea are the same as those reached by me about a year later in Aster.

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[11] KOMAROV, V., Flora Manchuriae. Acta Hort. Petrop. 25^2:335–853. *pls. 4–16.* 1907.

[12] COCKS, R. S., Annotated catalogue of grasses growing without cultivation in Louisiana. Bull. 10. Gulf Biologic Station, Cameron, La.

[13] JONES, MARCUS E., The willow family of the Great Plateau. pp. 32. Salt Lake City, Utah.

More recently MacLeod and Burvenich[15] have made an experimental study of the variability in the number of rays of *Chrysanthemum carinatum* and find essentially the same condition as in Centaurea, except that, unlike that species, *Chrysanthemum carinatum* shows the modes on the Fibonacci numbers, and as the mean number changes with the change of nutrition, the prominence of one mode is lessened as the neighboring one increases. The variation goes by steps or leaps from one favored value to the next. In discussing these "variation-steps" (*Varietietrappen*), three types of behavior are recognized: first, that in which the modes, whether one or several, agree with the terms of the relevant series, e. g., *Chrysanthemum carinatum*, 13 and 21; second, that in which the number of parts is constant or but very slightly variable and the values are those of the terms of the series, e. g., *Senecio Jacobaea*, 13, *S. nemorensis*, 5, *S. nemorensis octoglossus*, 8, etc.; third, the condition found in *Centaurea Cyanus* and in Aster in which the mode may fall upon any of the values lying between the terms of the series and in which as the mean values rise or fall the mode passes gradually through all the successive values. Seven variation-scales or series are recognized as fully demonstrated for one or more plant-characters; viz., (1) the Fibonacci series, 3, 5, 8, 13, 21, 34; (2) 5, 10, 15, 20 (carpels of Geranium); (3) 3, 5, 7 (leaflets of Trifolium); (4) 3, 6, 9 (flowers of Lonicera); (5) 2, 5, 8, 11 (flowers of *Cardamine pratense*); (6) 4, 8, 12, 16 (flowers of *Cornus mas*); (7) 4, 8, 16, 32, 64 (peristome of mosses). The author gives a lucid explanation of the cause for the existence of such series by referring them back to the period in development when a single additional cell-division will determine the leap from one stage to the next. The causes which incite cell-division may proceed gradually and continually but not until they have increased to a certain required degree will the additional cell-division take place, so that the effect is more or less discontinuous, though the combination of causes may be continuous.

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[14] MacLeod, J., Over de veranderlijkeid van het aantal randbloemen en het aantal schijfbloemen bij de korenbloem (*Centaurea Cyanus*) en over correlatieverschijnselen. Botanisch Jaarboek **12**:40–74. 1900.

[15] MacLeod, J., and Burvenich, J. V., Over den invloed der levensvoorwaarden op het aantal randbloemen bij *Chrysanthemum carinatum* en over de trappen der veranderlijkheid. Botanisch Jaarboek **12**:77–170. 1907.

It is also shown by MACLEOD in the paper just mentioned and by DE BRUYKER,[16] both working with *Chrysanthemum carinatum*, that the usual rule, according to which the earliest heads have the highest numbers, may be reversed by increasing the nutrition after the earliest heads are blocked out, thus fully demonstrating that the normal change which takes place from the beginning to the end of the flowering season is dependent upon the regular decline in the nutritional conditions. This seasonal periodicity is strongly emphasized in another paper by DE BRUYKER.[17] He finds that the number of flowers in the umbels of *Primula elatior* follows the same law of seasonal change as that followed by Centaurea, Aster, and Chrysanthemum above mentioned, and now known to hold for a number of species. Specimens of Primula growing in dry places had a lower mean number of flowers in the umbels than plants growing in moister places. The variation-curves for this character differ under different conditions and at different times, but always display modes on the Fibonacci numbers, 3, 5, 8, and 13. Evidence is given to show that these multimodal curves are not due to the presence of heterogeneity in the race, but are referable to the fact that development proceeds by more or less discontinuous stages, whose value in any particular instance depends upon the external and internal environment.

The complete dependence of the values of fluctuating characters upon the environment has also been well shown by KLEBS[18] in a comprehensive investigation of variation in the floral organs of *Sedum spectabile*. To avoid the possibility of dealing with mixed races, KLEBS has confined his studies to groups of individuals formed by taking cuttings from a single original plant. Growing these in several different habitats, he finds that for the stamens there is a different type of variation-curve in each habitat, which remains fairly constant so long as the habitat remains unchanged. Stamens of Sedum show the first of MACLEOD'S three types of behavior, with 5 and 10 as the favored classes. The various habitats produce curves ranging from a monomodal curve with 5 as the mode and with very slight variability, through a bimodal curve with different relative values of modes 5 and 10, to monomodal curves with 10 as the mode. It is shown that not only variability itself, but the nature of the variation-curve and all of its "constants" are the product of the environment, and are a measure of the uniformity or lack of uniformity of environmental conditions. He concludes that there is no such thing as absolutely constant characters, and that the most constant may become quite variable under special conditions. There is no real distinction between continuous and discontinuous variability, if the question of heredity is left out of account, as both of these as well as transitions between them may be induced by changes of the environment. The applicability of QUETELET'S law, which seems to indicate that variability is due to chance, depends upon the fact that the different values of the variable characters are determined by the coordinate action of several independently variable environmental factors. In an attempt to analyze the effective factors in the environment it is shown that the values of variable characters of Sedum increase directly as the quantity of carbohydrates increases and inversely as the quantities of available water and of salts increase. Chemical analysis of plants grown in the different habitats are presented in support of this view.

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[16] DE BRUYKER, C., De gevoelige periode van den invloed der voeding op het aantal randbloemen van het eindhoofdje bij *Chrysanthemum carinatum*. Handel. 10de Vlaamsch Nat. u. Gen. Cong., Brugge, S. 1906. pp. 6.

[17] ———, De polymorphe variatiecurve van het aantal bloemen bij *Primula elatior* Jacq.; hare beteekenis en hare beinvloeding door uitwedige factoren. Handel. 10de Vlaamsch Nat. u. Gen. Cong., Brugge, S. 1906. pp. 29. *figs. 2.*

[18] KLEBS, G., Studien über Variation. Roux's Arch. **24**:29–113. *figs. 15.* Jy. 1907.

PEARL[19] has studied the variability of *Chilomonas paramecium* and *Paramecium caudatum* living under favorable and unfavorable conditions. He finds that the types of the two populations are significantly different, that of the less favored culture being smaller and relatively more slender. The variability was the same in the two cultures; but the curve of the well-fed culture was positively skew, while the poorly fed presented a nearly normal variation-curve. There is a correlation of 0.6 between length and thickness, and also a significant correlation between size and form, which is recognized as opposing DRIESCH'S statement that proportionality is absolutely independent of size. In Paramecium, PEARL[20] also finds that there is a high degree of correlation or "assortative mating" between the two members of a pair of conjugating Paramecium, the coefficient ranging from 0.43 to 0.79 in respect to length, and 0.217 to 0.349 in respect to breadth. This strong tendency for like to mate with like is attributed to the inability of two individuals to unite successfully unless the mouths are of approximately the same size, the length of the mouth being closely correlated with other dimensional relations of the animal, particularly with the length. It is also found that the conjugants are differentiated as a class from the non-conjugating population, the former being smaller and less variable. From this the author concludes that conjugation tends to restrict rather than increase variability, and that the conjugant type bears much the same relation to the non-conjugants as that borne by the germ-cells of a metazoan to its soma. All evolutionary progress must rest upon changes in the conjugant type.

Of interest for the purely methodological side of biometry is a brief paper by DE BRUYKER,[21] in which it is shown that the means and quartiles, and indeed all the ordinates, of the ogive, when calculated according to the methods of GALTON, are a half-unit too low, due to the fact that GALTON constructs his curve on the extremity of the classes instead of on their mid-values. The suggested correction brings a very close agreement between the median and the arithmetical mean. DARBISHIRE[22] gives an interesting popular discussion of correlation of the kind dealt with by biometers, using as his basis the dice-throwing experiment of WELDON, in which the relation between two successive throws of dice are the correlated quantities considered, when a certain number of dice from the first throw are left on the table to influence the result of the second. When none of the dice are left, the two throws are totally unrelated and the correlation is zero; and when all are left, so that the second entry is an exact repetition of the first, correlation is complete. Tables are given showing the actual results of throwing 12 dice in this way under every possible condition as to the number of dice left back to influence the second throw, thus beautifully illustrating the different degrees of correlation between zero and unity.— GEORGE H. SHULL.

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[19] PEARL, R., Variation in Chilomonas under favorable and unfavorable conditions. 5:33–72. *figs*. 7. O. 1906.

[20] PEARL, R., A biometrical study of conjugation in Paramecium. Biometrika 5:213–297. *figs*. 9. F. 1907.

Symbiosis.—A recent paper by KEEBLE of Reading and GAMBLE of Manchester, England, continues the investigations of these two naturalists into the subject of the symbiosis of plants and animals.[23] Of late years these two men have been almost the only ones continuing this study, which, as the literature shows, was being actively pursued fifteen or more years ago.

Convoluta roskoffensis is a simple flat-worm living between the tide-marks on the northern coasts of Europe. It is usually green, owing to the presence in its tissue of chlorophyll-containing cells, which have been diagnosed as one of the Chlamydomonadeae. They resemble the members of the genus Carteria, but for certain reason KEEBLE, the botanical collaborator, hesitates to place them positively in this genus. The life-history of both components of the association has been worked out. From this study it is clear that the flat-worm begins its existence free from green cells. There is no transmission of green cells or even of rudimentary chromatophores (plastids) from parent to egg. The green cells appear to be chemotactically attracted to the eggs and egg-cases. Pure cultures of the alga may often be obtained from egg-cases which have attracted and become partly filled with the green motile cells. By carefully washing in sea-water free from the alga, colorless Convolutas can also be obtained. These will remain colorless or will turn green according to subsequent treatment. If kept in sea-

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[21] DE BRUYKER, C., Bemerkingen aangaande de Galton'sche curve. Handel. 10de Vlaamsch Nat. u. Gen. Cong., S. 1906. pp. 6. *figs. 2.*

[22] DARBISHIRE, A. D., Some tables for for illustrating statistical correlation. Mem. and Proc. Manchester Lit. and Phil. Soc. **51**:no. 16. pp. 21. diagrams 12. *1 dbl. pl.* 28 Je 1907.

[23] KEEBLE AND GAMBLE, The origin and nature of the green cells of *Convoluta roskoffensis*. Quart. Jour. Micros. Sci. **51**:167–219. *pls. 13, 14.* 1907.